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WIDEBAND CROSS-CONNECT SYSTEM AND PROTECTION METHOD UTILIZING SONET ADD/DROP MULTIPLEXERS

FIELD OF THE INVENTION

[0001] The present invention relates to a WideBand cross-connect system method that comprises at least one SONET add/drop multiplexer, functioning as Client IO Interface, and provides protection to traffic to be cross-connected.

BACKGROUND OF THE INVENTION

[0002] Telecommunications network operators typically require that at least some minimal level of redundancy be built into equipment they use in their networks in case of equipment failure. If redundancy were not provided, and an equipment failure occurred, traffic would be lost and customers could lose service for long periods of time while a technician was called in to troubleshoot for and replace the failed equipment with functioning equipment.

[0003] Typically, in a cross-connect system, there are redundant switching fabrics. One of these fabric functions as a working fabric and the other as a protect fabric such that if a failure occurs in one fabric the traffic in the other fabric can be used, minimizing traffic and service loss. Communications between the cross-connect interfaces and the

working and protect fabrics usually involve proprietary equipment and proprietary signaling methods. Additionally, many ADMs do not have the capability to switch traffic at the VT (VC) level as they are mostly broadband switch machines. With this view, it is decided that operating redundant WideBand switch fabrics into an ADM, a signaling method must be invented to provide the STS1 level of switching available within an ADM on even a single VT level failure.

[0004] The proliferation of the use of proprietary interconnections and signaling methods prevents cross-connects from using standardized interfaces with standardized signaling schemes, which are less expensive.

[0005] Thus, there is a need for a cross-connect system and protection method that takes advantage of standardized interfaces and signaling schemes.

SUMMARY OF THE INVENTION

[0006] The present invention relates to a WideBand cross-connect system and protection method that takes advantage of standardized interfaces and signaling schemes. The WideBand cross-connect system utilizes two switch fabrics communicating with at least one SONET add-drop multiplexer.

[0007] Payload Defect Indicator - Path (PDI-P) coding from the GR-253-CORE standard is utilized in many SONET add/drop multiplexers. PDI-P coding was developed and standardized in order to provide STS-1 path-level facility protection in unidirectional, path-switched rings (UPSR). However, it has not been used for equipment protection. The present invention

takes advantage of PDI-P coding to provide equipment protection for the switch fabrics.

[0008] The present invention has advantages over the prior art. Current solutions require custom-designed hardware and software to implement protection methods for the switching fabrics. The present invention enables the use of standard SONET add-drop multiplexers to provide this functionality.

[0009] An embodiment of the present invention relates to a cross-connect system and protection method utilizing PDI-P coding to select from the working and protect copies of a signal.

[0010] Another embodiment of the present invention provides a cross-connect system comprising two switch fabrics and at least one SONET add-drop multiplexer.

[0011] As such, it is an object of the present invention to provide for a method of protecting switching fabric signals in a cross-connect utilizing PDI-P coding.

[0012] It is another object of the present invention to provide for a cross-connect system comprising two switch fabrics and at least one SONET add-drop multiplexer.

BRIEF DESCRIPTION OF THE DRAWINGS

[0013] Figure 1 is a block diagram of a cross-connect system according to an embodiment of the present invention.

[0014] Figure 2 is a flow chart of a method for protecting traffic according an embodiment of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0015] The present invention will be better understood by reference to the accompanying drawings.

[0016] Referring now to Figure 1, a block diagram of a WideBand cross-connect system 100 according to an embodiment of the present invention is shown. Two VT switch fabric subsystems 101 and 102 are provided as well as SONET add/drop multiplexer(s) 103 and 104. SONET add/drop multiplexer(s) 103 and 104 may be a single add/drop multiplexer or a plurality of add/drop multiplexers. Moreover, it may be contained in the same enclosure(s) as the switch fabrics or in a separate enclosure(s). SONET add/drop multiplexers and switch fabric subsystems 101 and 102 are connected through 1+1 protected connections. SONET add/drop multiplexers 103 and 104 support SONET UPSR protection with switching criteria on PDI-P values. Consistent with the standard UPSR selection criteria (defined in GR-253-CORE and GR-1400-CORE) the SONET add/drop multiplexers 103 and 104 can select between the redundant connections using section, line and path layer defects down to the STS-1 level, as will be discussed in more detail with respect to Fig. 2.

[0017] Client interfaces 105w, 105p, 106w, 106p, 107w and 107p are shown accepting working and protect signals for a plurality of clients to SONET add/drop multiplexer 103. Although these interfaces are shown separately, some or all of these could be implemented in the form of an aggregate interface if desired, rather than separate physical

interfaces. Additionally, for client signals with no protect signal, working interfaces could be solely provided.

[0018] Each logical connection between switch fabric 101 and an interface with a SONET add/drop multiplexer 103 or 104 has a redundant connection between switch fabric 102 and a redundant SONET interface on the same SONET add/drop multiplexer. For instance, SONET add/drop multiplexer 103 has working switch interfaces 115w, 116w and 117w connected to working switch fabric 101 and protect switch interfaces 115p, 116p and 117p connected to protect switch fabric 102. Using a standard STS1 UPSR implementation, the traffic payload from the ADM will be broadcast to each of the working switch interfaces 115w, 116w and 117w and its respective protect switch interface 115p, 116p and 117p.

[0019] Likewise, working switch interfaces 125w, 126w and 127w between working switch fabric 101 and SONET add/drop multiplexer 104 have counterpart protect switch interfaces 125p, 126p and 127p between protect switch fabric 102 and SONET add/drop multiplexer 104. Ideally, each working switch interface 125w, 126w and 127w and each respective protect switch interface 125p, 126p and 127p would carry the same payload signals. However, problems could occur to a signal on one of the working or protect interfaces, on the lines connecting them with the switch fabrics, or within one of the switch fabrics that would alter the signal rendering it less desirable to pass to a client.

[0020] Referring now to Fig. 2, a method of providing equipment protection 200 according to an embodiment of the

present invention is now discussed, with reference back to Fig. 1.

[0021] In step 225, ADM 103 performs ADM functionality on the client interfaces 105, 106, 107 as provisioned to meet the network configuration (i.e. 2FBLSR, 4FBLSR, STS1 UPSR, Linear APS).

[0022] In step 230, ADM 103 will configure working and protect interfaces 115, 116, and 117, as STS1 UPSR. This configuration, by requirement, will broadcast all traffic payloads to both switch fabrics 101 and 102.

[0023] In step 235, each switch fabric 101 and 102, will provide VT level switching (also commonly referred to as connections) of the payloads independently but equally as per provisioning requirements. In addition, each switch fabric will independently monitor for equipment failures that would affect the traffic payload. In the event a failure is detected on one or more entities, the switch fabric will provide PDI-P codes to signal the presence and quantity of affected VT path failures associated with the logical connections embedded within each STS1 within each physical interface to the SONET add/drop multiplexer.

[0024] Step 240 indicates the receiving of traffic at ADM 104 on each pair of interfaces as 125w and 125p, 126w and 126p, 127w and 127p. Each of these is configured as UPSR pairs.

[0025] In step 245 each working and protect pair, 125, 126, and 127, at ADM 104, receive traffic from switch fabrics 101

and 102. ADM 104 provides comparison and conclusion of each STS1 level PDI-P value.

[0026] In step 245, analysis is performed on the value of the PDI-P codes received from each switch fabric 101 and 102. In order to provide the best possible signal to the client, via connections 135w and 135p, for example, SONET add/drop multiplexer 104 selects between signals entering interfaces 125w and 125p from switch fabrics 101 and 102, respectively, by comparing the PDI-P codes carried in the overhead of each signal and choosing the best signal based upon the defect level to be the signal output through interfaces 135w and 135p, for example, to the client in steps 245, 250 and 255. For example, if the comparison shows that the defect level is better for the working signal received at switch interface 125w, it is selected to be sent to the client from interfaces 135w and 135p in step 250. If the defect level is better for the signal from the protect interface 125p, it is selected to be sent to the client from interfaces 135w and 135p in step 255.

[0027] The present invention allows standard SONET add/drop multiplexers to provide both standardized customer interfaces to a cross-connect system and switch fabric protection. A network operator could even utilize pre-existing SONET add/drop multiplexers in a network designed by different manufacturers to create the WideBand cross-connect system. The only requirement would be that the SONET add/drop multiplexers support SONET UPSR protection with PDI-P codes.

[0028] Although the preferred embodiments of the present invention have been described and illustrated in detail, it

will be evident to those skilled in the art that various modifications and changes may be made thereto without departing from the spirit and scope of the invention as set forth in the appended claims and equivalents thereof.